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A
CHEMICO-MEDICAL
E S S A Y
TO EXPLAIN THE OPERATION
on OF
O X I G E N E,
OR THE BASE OF
V I T A L A I R
ON THE
H U M A N B O D Y.

By BENJAMIN DE WITT, M. P. M. S.
CITIZEN OF THE STATE OF NEW-YORK.

*Whence in bright floods the VITAL AIR expands,
And with concentric spheres involves the lands;
Pervades the swarming seas, and heaving earths,
Where teeming nature broods her myriad births;
Fills the fine lungs of all that breathe or bud;
Warms the new heart, and dies the gushing blood;
With life's first spark inspires th' organic frame,
And, as it waffles, renews the subtile flame.*

DARWIN.

P H I L A D E L P H I A :

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I M P R I M A T U R,

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INAUGURAL THESIS,

SUBMITTED TO THE

EXAMINATION

OF THE

REV. JOHN EWING, S.T.P. *Provost*,

THE

T R U S T E E S

AND

MEDICAL PROFESSORS

OF THE

UNIVERSITY OF PENNSYLVANIA,

FOR THE

D E G R E E

OF

DOCTOR OF MEDICINE.

ON THE THIRD DAY OF MAY, 1797.

NON TUMUM EX FULGORE, SED EX FUMO DARE LUCEM COGITAT.

HOR.

T O

DR. WILLIAM M'CLELLAND,

OF THE CITY OF

A L B A N Y,

THIS ESSAY IS INSCRIBED,

AS A PUBLIC TESTIMONY

OF RESPECT AND ESTEEM,

BY HIS

SINCERE FRIEND

AND FORMER PUPIL,

THE AUTHOR.

ESSAY, &c.

INTRODUCTION.

PERHAPS no branch of natural philosophy has more engaged the attention of the learned, or been more successfully cultivated, than the nature of the common air which surrounds us. Philosophers formerly imagined it to be a pure, simple, elementary fluid; hence their attention was chiefly engaged in investigating its mechanical properties. Modern discoveries, however, evince that it is by no means an elementary substance; but composed of different constituent parts, possessing chemical qualities, and having a very extensive and wonderful agency, in a great variety of the operations, both of nature and of art.

THE knowledge of its being essential to the preservation of animal life must have been coeval with mankind; it was from the beginning, as it is now "the breath of life:" But in what manner this was affected has long remained an impenetrable mystery. It was left for modern chemists to solve this difficult problem. By decomposing the air which we breathe, and by shewing the properties of its constituent parts they have enabled

us to view some of the most important functions of the animal system, in a very different light from what our ancestors were accustomed to do.

THE beautiful experiments of Lavoisier prove that atmospheric air is composed principally of two elastic fluids. He procured them in a separate state,* and found that in the one, an animal died in a few seconds; in the other it became remarkably lively. A taper plunged into the one was immediately extinguished; in the other it burnt with a dazzling splendor. In short, the one incapable of supporting animal life and combustion; the other possessing that property in a high degree. The first was called Azotic (or more properly Nitrogene) gas; the other Oxigene gas, or vital air.

As a further proof of this important truth, if we recombine these two elastic fluids in certain proportions, we reproduce an air precisely similar to that of our atmosphere, possessing the same powers of supporting combustion, respiration and calcination.†

By other experiments it is found that atmospheric air contains also a small portion of carbonic gas (fixed air), and most probably likewise some dydrogene gas (inflammable air); but neither of these appear to be essential to its constitution.

As that property of air which renders it capable of supporting life seems to reside essentially in one of its constituent parts, it becomes an important and interesting enquiry, which deserves to be minutely investigated, What is its nature, and what its effect upon the human body?

* Lavoisier's Elem. Chemist. p. 82.

† See Lavoisier, Berthollet, tom. ii. p. 35.

OF OXIGENE GAS, or VITAL AIR.

THIS species of air was first discovered by the celebrated Priestley, on the 1st. of August, 1774.* He called it dephlogisticated or pure air. Scheele called it empyreal air, and Lavoisier first named it highly respirable or vital air. The French chemists afterwards gave it the name of oxigene gas,† from its property of forming acids by combining with certain substances. This discovery has been emphatically stiled the “pride of modern philosophy.”

OXIGENE GAS exists in our atmosphere in the proportion of twenty seven parts to the hundred, according to Lavoisier.‡ It is compounded of a base or radicle, and caloric (fire, heat, igneous principle, &c.) which maintains it in a state of elastic fluidity. Its radicle or oxigene has never been obtained in a separate state or solid form, on account of its great attraction for other bodies; it appears however to approach to this state, as it exists in water in the proportion of 85 parts to the hundred. It possesses the exclusive property of supporting respiration and animal life: All the other species of air hitherto discovered appear to be inadequate, or perhaps injurious to that effect.

A LARGE portion of the oxigene of our atmosphere must be continually employed in the breath-

* Mr. Scheele, it is said, made the discovery also nearly about the same time, though he did not know of Dr. Priestley's experiments. Lavoisier says he also discovered it; but it is more probable, that he received the hint in a conversation with Priestley when in France.

† From the Greek words (*oxus*) “sharp or acid,” and (*geinonmai*) “to beget or produce.”

‡ Elem. Chemist. p. 86.

ing of animals, the burning of fuel, the putrefaction of substances, and numerous other operations carried on in the great elaboratory of nature. This consumption is incessantly supplied by the action of the solar rays upon growing vegetables: hence an equilibrium is maintained, in the proportion of the constituent parts of the atmosphere. Priestley, Ingenhousz, and others, have sufficiently proved that most plants, exposed to the action of light, perspire vital air, and absorb the mephitic: Man, on the other hand, emits mephitic, and subsists upon vital air; hence the vegetable and animal kingdoms appear to labour for, and mutually to supply each others wants.

OF OXIGENE AS RECEIVED INTO THE SYSTEM BY THE LUNGS.

AIR taken into the lungs by respiration is diminished in quantity, and parts with its vital property, which experiments shew to be absorbed by the blood. Chaptal says, that the air in which five sparrows had died yielded only $\frac{17}{100}$ of Oxigene. Count Morozzo placed ten sparrows in succession under a bell of glass filled with this gas, inverted over water. The first died in five hours and twenty three minutes, by which the air was greatly diminished; the second died in two hours and ten minutes, with a further diminution of the air, and the third in one hour and thirty minutes, without producing any visible alteration. This diminution by the breathing of man is 360 cubic inches in an hour, according to the accurate experiments of M. de la Metheric.*

* The calculations of Hales in his Statics, and the experiments of Chaptal and Lavoisier vary somewhat from this.

BLOOD we know has so strong an attraction for oxigene as to absorb it from the air after it is drawn out of the body ;* but as it does not come immediately in contact with the air in the lungs, it was difficult to conceive how they should unite ; and it was supposed that the intervening membranes would form a barrier to the reception of any part of the air into the system. This difficulty was entirely obviated by an experiment of Dr. Priestley : He enclosed a quantity of blood in a bladder, apparently more dense and impermeable to air than the vesicles of the lungs, and upon exposing it, the blood which it contained soon became as florid as if it had been in the open atmosphere. Dr. Goodwyn also found that even the coats of the vessels in different parts of the body, were no obstruction to the process of floridification, which indicates the reception of oxigene ; the same effect is also produced though the blood being covered with a stratum of serum to the depth of two inches or more ;—oil, saliva or water however prevent its action.

THE experiments of Darwin† and Luzuriaga,‡ however, prove that air does not, and cannot consistently with animal life, exist in the blood in a gaseous or æriform state ; we must therefore necessarily conclude, that it takes on another form on entering the system : This no doubt is effected by its being decomposed, and parting with so much of its caloric as was necessary to maintain it in a state of elastic fluidity. In no other way can it be so satisfactorily explained.

* See Girtanner's experiments.

† Med. Com. vol. vi. p. 35.

‡ Inaug. Dissert. Edin.

THE air which is emitted from the lungs after having answered the purposes of respiration, is found not only to have lost a portion of its oxigene, but at the same time acquired a new principle, to wit, carbonic or fixed air: This is proved by causing the expired air to pass through lime water, which instantly becomes turbid; if received through tincture of turnsole, it reddens it, and if through a solution of caustic alkali, it renders it mild and effervescent.

THE nitrogene gas, which constitutes by far the largest portion of the atmosphere, appears to undergo no perceptible change, either in quantity or quality, by being breathed.*

OF ~~O~~ XIGENE,

AS RECEIVED INTO THE SYSTEM, BY THE STOMACH AND INTESTINES.

THAT oxigene is taken into our bodies by the stomach as well as by the lungs, is not so evident from direct experiment. It can hardly be doubted, however, that it constitutes a large portion of the constituent parts of our daily aliment, particularly of acids and vegetables; and in that state is most probably absorbed into the blood, in some measure to answer the purposes of the animal economy. "No substances, (says Dr. Beddoes) are better calculated than acids, at least, to impart oxigene to the system; they contain it in abundance, and they easily part with it."† It does not appear

* See Priestley, Lavoisier, Chaptal, Goodwin, &c.

† Letter to Dr. Darwin.

improbable to me that oxigene may be also imparted to the blood, circulating through the vessels immediately on the surface of the intestines: When we consider that the intestinal canal appears to be the only interior part of the body, except the lungs themselves, to which atmospheric air has access; and that this elastic fluid is swallowed in considerable quantities: When we consider the astonishing congeries of small blood vessels spread upon its surface; and further, when we reflect with what ease oxigene is admitted through mucous membranes, and even through the coats of large veins when laid bare; and finally, when we consider the change which the air undergoes in its passage through this canal, there can hardly remain a doubt that oxigene may in this manner be imparted to the blood in considerable quantity; more especially as the area of the whole surface of the intestines is perhaps as large as that of the lungs.

OF OXIGENE AS TAKEN INTO THE SYSTEM BY THE SKIN.

IT has been doubted whether oxigene could be taken into the system by the surface of the body: If, however, water is absorbed by the pores of the skin, it is evident that in this way oxigene is taken in, like that with the aliment by the intestines. Whether the water after entering the system is decomposed, and its oxigene set at liberty, to answer other purposes of the animal economy, remains perhaps yet to be determined. Girtanner asserts, that from some of his experiments it is clear that water is decomposed and recomposed continually in organized bodies. But besides, we

have some reason to conclude that oxigene is absorbed from the air by the skin, in a similar manner to that by the lungs. This is rendered probable from the striking resemblance between the matter of perspiration, and the exhalation from the lungs. The experiments of the Count de Milley, and the observations of Foquet prove that the genuine matter of perspiration is carbonic gas, the same with that exhaled from the lungs; like that it precipitates lime from its solution, and like that it is incapable of supporting flame and respiration. It appears further probable from those cases in which the lungs have been almost totally destroyed by disease;* and from which patients have survived for years, almost wholly deprived of the advantage of respiration. In those cases the skin or the intestines must have in some measure supplied the office of the lungs in providing the system with oxigene. What quantity the skin does absorb is not yet (so far as I know) proved by actual experiments, though Dr. Beddoes asserts (upon what authority I know not) that “it is found
 “in equal times to take in three or four times as
 “much oxigene air as any other.” Dr. Fothergill† also mentions that it has lately been discovered that vital air is absorbed by the skin in considerable quantities.

* See Blumenbach.

† On the suspension of Vital action, 1795.

OF THE EFFECTS OF OXIGENE ON THE BLOOD.

1. *On the crassamentum or red globules.*

• LOWER, in his treatise de corde, long ago observed, that the blood returned from the lungs by the pulmonary veins, was of a more florid colour than that in the arteries. The same was afterwards observed by Boerhaave, Haller, Hewson, and others; and has since been noticed by almost every author who has written upon the subject. The cause of this difference in the colour of the venous and arterial blood has much engaged the attention of physiologists; but no satisfactory explanation could ever be given for it, until the immortal Priestley discovered that it is owing to what he calls dephlogisticated or vital air.* He exposed a quantity of venous blood to common air, and found that by agitation it immediately became of a more florid colour, and that this effect took place in a higher degree and in a shorter time when exposed to oxigene gas. On the other hand, blood exposed to any of the other airs, in a short time lost its bright red colour, and became black; but resumed its floridity upon being brought in contact with vital air. Goodwin inclosed a quantity of

* John Mayow in the obscurity of the last century (1668) was acquainted with many of the properties of oxigene air, though he did not procure it in a separate state. In his *Traët de respiratione*, he proved by experiment that the air is diminished both in respiration and combustion; that the office of the lungs is to separate from the air, and convey to the blood, one of its constituent parts, which he called nitro atmospheric, or fiery air particles: He supposed this coloured the blood, and was necessary to all muscular motion, and especially to the heart. His writings however seemed to be little taken notice of.

See Dr. Beddoes on Exp. of a Phil. in the last. cent.

oxigene gas in a glass receiver, inverted over mercury, and introduced into it 4 ozs. of blood, drawn from the jugular vein of a sheep; it instantly became florid, and the mercury appeared to rise in the receiver. Blood also becomes of a dark colour when exposed in vacuo, according to the experiments of Beccaria, which have since been repeated by Dr. Priestley with the same result.

THE blood returned from the extremities by the veins, being of a darker colour than that in the arteries, can only be explained by its having lost a part of its oxigene in the course of the circulation; and not by its having acquired a larger portion of hydro-carbonic matter, as has been conjectured by some: for if oxigene gas be injected into a vein, the blood becomes as florid as that in the arteries,* without however having parted with its supposed superabundance of carbone.

SEVERAL opinions have been offered as to the nature of that principle or property in the crassamentum of the blood, by which it is peculiarly adapted to become floridified by an union with oxigene; but I confess they all appear to me to be unsatisfactory. The most probable opinion perhaps is, that it is owing to iron reduced to a state of red oxid: but it is difficult to conceive how so small a portion of iron as the blood contains, should diffuse that florid colour through so large a mass of fluid; and it does not appear to have so strong an attraction for oxigene at the ordinary temperature of the body, as to account for the instantaneous change which takes place in the blood circulating through the lungs. Other causes might perhaps be suggested with equal probability of

* See Hewson, Cirtanner and others.

truth.* It would afford an extensive subject for much plausible reasoning to a speculative theorist, but would lead too far into the field of conjecture. Upon this, as well as many other subjects connected with the animal economy, we must consent to remain in doubt, until by future experiments and discoveries, we shall acquire a more extensive knowledge of the sublime operations of the chemistry of nature.

OF THE EFFECTS OF OXIGENE

2. *Upon the gluten, or coagulable lymph of the Blood.*

THAT oxigene acts upon the red globules of the blood, must now be evident to every one of the slightest observation, by the instantaneous change which it produces in its appearance, converting it from a dark red to a bright vermilion colour. But that it also produces essential effects upon the other component parts of the blood, is not so evident at first view : It is, nevertheless, highly probable to me, that its agency upon the coagulable lymph particularly, is no less considerable and important. This opinion is rendered probable when we consider that in those cold blooded animals, whose blood has no red globules, respiration is as essential to their existence as any other. In a number of very accurate experiments made

* Dr. Darwin supposes it to be owing to phosphorus, but I believe only upon conjectural grounds, as appears from the following lines :

“ When air’s pure essence joins the vital flood,
“ And with phosphoric acid dyes the blood,—”

by Doctor Beddoes,* in order to ascertain the comparative effects of common and vital air upon animals; the blood appeared uniformly to coagulate much sooner and firmer, of those animals which had for some time breathed oxigene air, than of the others which lived upon common air, and were killed in the same instant. On the other hand, in most of those cases related by authors, in which we may conclude with tolerable certainty, that there was a deficiency of oxigene in the system; such as scurvy, for instance, and the cases given by Dr. Sandifort, of Leyden† and others; in which, from organic affection of the heart, but a minute portion of blood circulated through the lungs to the oxidated; so far as I can judge from their imperfect accounts of the state of the blood, it always appeared to have lost in some degree its property of coagulating. From these considerations I am inclined to believe, that the coagulable lymph of the blood owes its property as such in a great measure to this vital principle of the air; and that the influence of oxigene is perhaps essentially necessary to bestow upon it that condition, which renders it fit to become concreted into animal fibres, and to nourish the solid parts of our body.

OF THE INFLUENCE OF OXIGENE IN PRODUCING ANIMAL HEAT.

ANOTHER important effect accomplished by the agency of oxigene received into the body, is the production of animal heat. A very opposite

* On Factitious Airs, p. 16, and elsewhere.

† Observationes Anatomico-Patholog. Luqd. Batav. 1777, page 14.

circumstance to the whimsical notion of those, who imagined the lungs to perform the office of a bellows to cool the blood. Respiration, as we have already seen, is to be considered as an operation by which vital air continually passes from a gaseous to a concrete form ; it must therefore at each instant abandon so much of its heat as was previously necessary to maintain it in a state of elastic fluidity ; this heat being set at liberty, now manifests itself in a free and sensible form ; hence an abundant source of animal heat generated in the lungs.* Persons who have respired vital air all agree in affirming, that they have perceived a gentle warmth, vivifying the lungs, and extending to the more distant parts of the body. But the lungs are not the sole focus or fire place where heat is produced ; for we have the strongest reasons to believe that it is also evolved in the course of the circulation, and particularly in the extremities of the arterial system. If the lungs were the only source of animal heat, the parts of the body would become cold in proportion to their distance from this centre ; for we know that heat decreases as it recedes from the source whence it originated. If this were the case too, no part would be susceptible of an increased heat, as is manifestly the case in topical inflammation ; nor no part except the lungs would resist the topical application of cold.

THOUGH oxigene in assuming the concrete form, by combining with bodies, looses some portion of its caloric, that is, so much as was necessary to keep it in an æriform state, it is nevertheless certain, that it carries a large quantity of latent heat along with it in assuming the solid form in

* See Crawford's experiments on Animal Heat.

various combinations;* if then this be the case, as it unites with the blood, it is easy to explain how it should give out this heat, in the course of the circulation, by entering into new combinations.

THAT the evolution of heat is intimately connected with the action of the arteries, is a familiar fact; and it seems highly probable that their minute ramifications are of such importance to the generation of heat, that as their action is weaker or stronger, a proportional diminution or increase takes place, in the heat of a part or the whole of the body. They appear to have the power of decomposing the blood, as in the various secretions, and of recompounding it again; and as the affinity for substances, is variously changed, when they undergo any chemical alterations, it is easy to conceive how blood when it undergoes these changes, should throw out a large quantity of its latent heat.

“As the evolution of heat” (says Dr. Darwin) “attends almost all chemical combinations, it is probable that it also attends the secretions of the various substances from the blood, and that the constant combination or production of new fluids by means of the glands, constitutes the more general source of animal heat. This seems to be evinced by the universal evolution of the matter of heat, in the blush of shame or anger, in which at the same time an increased secretion of perspirable matter occurs.”

FROM these general and uniform sources of animal heat in the body, we can easily explain, how all the parts of the body retain nearly the same

* See Lavoisier's Elem. Chemist.

degree of temperature, and why it is so little varied, whether the subject be exposed to the rigors of the coldest climate, or placed beneath the fervors of a tropical sun.

OF OXIGENE AS A STIMULUS TO THE HEART AND ARTERIES.

THE stimulating effects of Oxigene upon the heart and arterial system is now established by a multiplicity of experiments and observations. I shall mention only one. A young man having breathed pure undiluted Oxigene air for several minutes, his pulse which before the experiment was 64, now rose to 120 beats in a minute*. There is so intimate a connection between the quantity of air received by respiration, and the action of the heart and arteries, that by accelerating or retarding respiration by an effort of the will, any one may at pleasure greatly increase or diminish the action of his pulse, both as to frequency and force. The continuance of the action of the heart and arteries during life, seems to be very entirely owing to the incessant influence of this vital principle of the air;† for neither the stimulus of heat, nor the mechanical stimulus of the blood, appear to be at all adequate to this effect, as is abundantly manifested by the experiments of Goodwin‡ and others; and why does not the circulation go on, when the lungs are dis-

* Minutes of the Society for Philosophic Experiments, by Dr. Higgins, p. 146.

† Sir Isaac Newton imagined that the atmospheric air might communicate an acid vapour to the blood of the lungs, which was necessary to keep up the action of the heart.—Optics, p. 351.

‡ Connection of life with respiration, &c.

tended with any other air which is inimical to life, only in so far as it withholds Oxigene from the blood?

OXIGENE differs from many other stimulants, perhaps, in this respect, that it does not appear to diminish, but rather to increase the irritability of the muscular fibre*. It seems indeed to be so intimately connected with the irritability of the heart, and so essential to its support, that in proportion to the increased or diminished quantity of vital air received into the system, there takes place a corresponding change in the irritability of that vital organ; and moreover, as irritability in a great measure accompanies and keeps pace with animal heat through life, it may be concluded with much plausibility, that it depends upon the same principle; and hence, that Oxigene may be truly the source and proximate cause of the irritability of the heart and muscular fibres, which enables them to perform the functions of vitality. This doctrine receives additional stability by being long since adopted†, and lately so well illustrated by the learned Dr. Fothergill in his ingenious prize dissertation on the suspension of vital action.

EFFECTS OF OXIGENE UPON THE NERVES. BRAIN, AND MIND.

THAT Oxigene acts powerfully upon the sentient extremities of the nerves, may be inferred, from an experiment mentioned by Dr. Ingenhousz, and since several times repeated by Dr. Beddoes,‡

* Girranner's Experiments.

† Hints on Animation, 1783.

‡ On fastitious Air, page 43.

that if the finger be blistered, so as to lay bare the naked and sensible skin, and exposed to common air, a smarting pain occurs; in Oxigene air it is more severe, but when exposed to azotic or carbonic gas, it entirely subsides, and returns immediately upon being withdrawn into atmospheric air.*

THE ingenious Dr. Darwin, thinks that Oxigene taken into the system by respiration, “affords the material for the production of the sensorial power, which is supposed to be secreted by the brain, or medullary part of the nerves, and that the perpetual demand of this fluid, in respiration, is occasioned by the sensorial power which is supposed to be produced from it, being too subtile, to be long confined in any part of the system.”—“The necessity of perpetual respiration shews” (continues he in another place,) “that the Oxigene of the atmosphere supplies the source of the spirit of animation, whence it is probable that Oxigene gas may increase the secretion of sensorial power, as indeed would appear from its exhilarating effect on most patients.”† Be this as it may, numerous facts and experiments authorise us to say, that it uniformly produces vivacity, cheerfulness, gentleness, and serenity of mind, exhilarates and enlivens all the intellectual operations,‡ and produces alacrity and vigor in all corporeal exertions. It is very remarkable that Oxigene air, even when infused into the cellular substance of dogs, appeared in a short time to manifest stimulating effects: the animals became

* Dr. Thornton says he has seen a man whose finger was amputated, receive immediate relief from pain, by plunging his hand in fixed air.

† Zonomia, part 2. vol. 2. p. 377 & 399.

‡ “May not chemistry be able to exalt the powers of future poets and philosophers.”

exceedingly lively (*maxima alacritas*) by the experiments of Dr. Maxwell.*

OF THE EFFECTS OF OXIGENE UPON THE SKIN.

AMONG the numerous causes that have been called forth to explain the variation of colour in the human race, the agency of Oxigene has not been neglected; Dr. Beddoes was once nearly elated with the hope of having discovered the method of turning the Ethiopian white, by means of the Oxigenated muriatic acid air: The arm of a negro was introduced into a large jar full of this air, and the back of his fingers lay in some water impregnated with it at the bottom of the vessel, they acquired an appearance as if white lead paint had been laid upon them, but it did not prove permanent; a lock of his hair was whitened by this acid. Similar experiments have been made by the professor of chemistry in this university, but without success; it produced no change either on the skin or the hair. "Can the Leopard change his spots, or the Ethiopian his skin?"

OF THE EFFECTS OF OXIGENE UPON THE BONES.

BY chemical analysis, the bones are found to be composed principally of Phosphoric acid, and calcareous earth; now as we know that phosphorus, as well as every other substance, is reduced to a state

* Edin. 1787.

of acid only by uniting with oxigene, which seems to be the universal acidifying principle in nature; it is evident that its agency must be essential to the formation of bones. Phosphorus by its strong attraction for Oxigene, probably unites with it as soon as it is received into the system, this again combining with the calcarious earth taken in with our aliment, will probably give the true theory of the formation of bones. This idea is farther confirmed, by a circumstance occurring in certain cases of disease in which the bones become soft and flexible; In many of these cases the urine was found upon examination to contain a very large quantity of phosphoric acid, and sometimes a plentiful sediment of earthy matter. May not the other solids of our bodies be formed by a chemical combination somewhat similar to this?

OF OXIGENE AS A NUTRIMENT.

“SPIRITUS etiam alimentum est,” are the words of ancient Hippocrates. From the large quantity of oxigene taken in, and from its entering so largely into the composition of our bodies;—it may, I think, with propriety be classed among the nutritious substances. It seems, indeed, when considered in this light, to be of much more immediate consequence to the preservation of life, than any of the other alimentary matters—“It is impossible to doubt (says Dr. Beddoes) that we are nourished by the lungs as truly as by the stomach, and that what we take in at the former entrance, becomes like our food, a part of the substance of our solids, as well as our fluids.”

OF THE EFFECTS OF OXIGENE ON THE FÆTUS IN UTERO.

WHEN we contemplate the young and tender fœtus, closely wrapped up in its mother's womb, and apparently cut off from all communication with the external air, we should at first be apt to imagine, that it was entirely deprived of its genial influence; but this cannot be, for without it, all animated nature would become a lifeless mass. It must therefore be through the medium of its parent, that it is continually supplied with this necessary fluid, and the placenta we know is the only communication that exists between them. It has generally been supposed that the blood of the mother was transmitted immediately to the fœtus through this medium, and that its sole use was for the purpose of conveying nourishment; but I am rather disposed to believe that no such communication takes place. It is more probable that the maternal blood is only conveyed by arteries to the placenta, and immediately returned by veins, after it has imparted its superabundant oxigene to the fœtal blood circulating through it, by an operation similar to what takes place in the lungs of air-breathing animals, and the gills of fishes; in short, that the placenta serves the office of a respiratory organ to the fœtus, while it remains in the womb.* Oxigene communicated in

* This doctrine I endeavoured to establish and vindicate, in a memoir read before the Philadelphia medical society on the 28th of December, 1796. To have entered into a detail of the arguments here, would have been foreign to the subject. It is an opinion that was held as early as the last century by John Mayow, Sir Edward Hulse, and some others; but since it was controverted by the late Alexander Monro, it appears to have been the prevailing opinion, that the placenta was an organ of nutrition only, "owing perhaps (as an ingenious author observes)

this way from the blood of the parent, to that of the child, sheds all that healthful influence upon it, which it continually does upon animals who live in the open air.

rather to the authority of so great a name than to the validity of the arguments adduced in its support." That there is no direct communication between the maternal and foetal blood, may be inferred,

1st. From the fact, that the vessels of the uterus cannot be injected from the placenta.

2nd. From the fact, that if the child and placenta are both delivered suddenly, and the child, though alive, does not yet breath, the blood may be felt circulating with force through the funis, and when it is slightly pressed, the arteries swell between the pressure and the child, and the vein between it and the placenta, from the surface of which, however, no blood flows.

3d. From the fact, that while the placenta adheres firmly to the uterus, which remains still distended by a child, if the funis be divided no more blood flows from it, than seemed to be contained by the placenta.

4th. From the umbilical vein carrying arterial blood. If that blood was derived immediately from the mother, it must have been changed from arterial to venous, as takes place in every other part of the body.

5th. From the probable utter impossibility of the embryo heart to propel forward the column of blood in the winding vessels of the uterus, on its way to the mother's heart, &c. &c.

If, then, no direct communication exists between the blood of the mother and child, the placenta may be inferred to be a respiratory organ,

1st. From its structure, as demonstrated by Mr. John Hunter.

2nd. From the blood returning of a florid colour to the foetus.

3d. From the foetus immediately dying as soon as the placenta is separated from the uterus.

4th. From its analogy with the mode of existence of fishes in water, and the chick in ovo, &c.

OF THE MORBID EFFECTS OF OXIGENE.

OXIGENE, though it is the support and staff of life as it exists in its diluted state in our atmosphere ; yet, when pure and unadulterated, it cannot be breathed without manifesting a hurtful tendency ; and by producing as it were an excess, finally extinguish life ; like Milton's darkness, from an excess of light : " for as a candle burns out (says Dr. Priestley) much faster in this than in common air, so we might, as may be said, live out too fast, and the animal powers be too soon exhausted." Like sensual gratifications, in moderation it is the cordial, in excess the bane of life. Mr. Lavoisier found that animals died when confined in oxigene air, long before it became unfit for respiration : On dissection death seemed to have been occasioned in every instance by an ardent fever and an inflammation ; the flesh was of a very red colour, the heart livid and turgid with blood, especially the right auricle and ventricle, the lungs were very flaccid, but red, even externally ; they were also turgid with blood.*

IN allusion to the above fact, concerning the morbid effects of oxigene upon animals, Dr. Beddoes asks, " May not the slower and differently modified inflammation of the lungs in pthisis, originate from a smaller excess of oxigene, thrown into the system in a more gradual manner ?" This the Doctor labours to establish by much ingenious reasoning, and many plausible arguments. †

BUT whether there be really a superabundance of oxigene in the systems of pthisical patients or

* Mem. de la Societé Roy. de Med. T. and p. 575.

† See his Treatise on calculus, scurvy, pthisis, &c.

not, it is easy to conceive that the ordinary proportion of oxigene in the air may exert morbid effects, and aggravate this, as well as many other inflammatory complaints, by acting as a powerful stimulus disproportioned to the excitability of the system: and hence, we need not wonder that in twenty cases of this disease, in which oxigene air was inspired, as described by Fourcroy, it uniformly aggravated the complaint. Upon these principles too we might hope for the beneficial effects of a lowered atmosphere, in many diseases of high excitement, which is indeed already manifested by the experience of Dr. Beddoes and others.

SINCE the active agency of oxigene upon the body has become known, physicians have not failed to call in its assistance to explain that state of the atmosphere which seems to dispose to epidemic and malignant disorders. Dr. Rush* ascribes it to a superabundance of oxigene, and Dr. Mitchell,† of New-York, to a certain combination of oxigene and azote, or nitrogene. But all our knowledge upon this subject appears to me to amount, as yet, to no more than plausible conjecture. I do not know any facts or experiments which lead to a knowledge of that precise condition in which it consists; and I might perhaps quite as well be contented to call it the “divine something” of Hypocrates, the “mineral vapour” of Sydenham, or the “marsh miasma” of the present day, as to attempt to elucidate its nature by abstract reasoning from our present data. However, we may venture to conclude from what we already know of the properties of oxigene, that its morbid effects in undue quantity will be found to keep pace with

* Med. Enquiries and Observations, vol. iv. p. 75.

† On the gaseous oxid of azote.

the extent of its salutary influence over the human frame. Under what circumstances this may happen, or when it takes place, experiment is perhaps only adequate to determine.

ONE probable effect of oxigene, however, deserves to be taken notice of; that is, the change which it would seem to produce in the matter of ulcerations, as of small pox, cancer, abscess, &c. Dr. Darwin* says, “the blood in small pox will not inoculate that disease, if taken before the commencement of the secondary fever; because the contagious matter is not yet formed; but after it has been oxigenated, through the cuticle in the pustules, it becomes contagious.†” The matter of cancers does not seem to acquire a contagious quality until it is exposed to the air; hence they are often successfully extirpated in this state; but after they become ulcerated, a hectic fever often occurs, and the neighbouring glands become swelled. The matter of common abscess too, appears to be mild and inactive, till it becomes changed by exposure to air, when it acquires a stimulating and fever producing property. Are not these morbid effects of oxigene?—It is without doubt from this principle of the atmosphere too, that we are to explain the deleterious effects of air, when accidentally admitted into any of the large cavities of the body; and it is easy to account for the inflammation which generally ensues, from the highly stimulating property of the oxigene which it contains. From these obvious effects which it seems uniformly to produce, it has been very ingeniously employed for the cure of hydrocele, by injecting it

* Zonomia, part 2, vol. i. p. 91.

† This is the reason, he says, why the foetus in utero is sometimes infected after the secondary fever, but never before it.

into the tunica vaginalis testis after evacuating the water, and with constant success.

OF OXIGENE AS A REMEDY IN CERTAIN DISEASES.

OXIGENE, as being a powerful and durable stimulus which seems to exert its influence over the whole body, may be had recourse to with perhaps singular advantages, in many of those cases in which this class of medicines has been recommended, as well as in those in which there may be supposed to be a deficiency of that principle in the system. When a super-oxygenated air is inspired for some time, it increases the strength, and gives an alacrity for motion; produces gaiety and serenity of mind; mitigates pain, and disposes to sleep; increases the appetite for food, and strengthens the powers of digestion; diffuses a gentle warmth over the whole body, and imparts a degree of insensibility to cold; gives life to the eye, and bloom to the countenance. I shall briefly enumerate some of the principal diseases in which its efficacy seems already to be manifested.

Asphyxia.—Suspended animation from submersion, strangulation, and certain unrespirable airs, being produced by the privation of oxigene, it must be evident that the only probable method of recovery is, to restore this to the blood by inflating the lungs. It is reasonable to believe that a super-oxygenated atmosphere would be most effectual;* at any rate, the method of inflating by the

* The superiority of vital air in restoring animation (says Dr. Fothergill) has been confirmed by many respectable writers both at home and abroad.

vitiated breath of another, as is too often done, appears to me very objectionable.

Scurvy.—It is probable that the efficacy of acids and vegetables in the cure of scurvy, is in some measure to be ascribed to the oxigene which they impart to the system. What effects breathing an oxygenated air would have, remains to be determined.

Typhus.—Dr. Thornton and Mr. Townsend have found it of remarkable efficacy in this disease. Dr. Wood from his own experience recommends nitre, and ascribes its power to the oxigene which it imparts to the blood; “Nitre (says Dr. Beddoes) is doubtless decomposed in the *primæ viæ*, and capable of supplying much oxigene.”

Asthma.—“In true asthmatic fits, its beneficial effects have already been many times experienced; no sooner does it touch the lungs, than the livid colour of the countenance disappears, the laborious respiration ceases, and the functions of all the thoratic organs, go on easily and pleasantly again.”*

Cancer.—Inhaling oxigene air seems to have been useful in, if not entirely removed this dreadful complaint.

Schrofula.—Schrofulous ulcers, tumors, and opthalmia's, have yielded to it, and been completely cured, as attested by Dr. Thornton and others. Is the remarkable efficacy of the juice of sorrel in curing schrofulous ulcers, owing to the oxigene which it imparts to them? In every ulcer to which it is applied, there takes place a change from a dead pale to a scarlet colour.

* Beddoes.

Herpes.—A case of eruptions on the face, purple blotches on the body, hard scales on the arms, a dark coloured deep ulcer on the leg, and loss of sight, that had resisted every remedy for thirty years, was radically cured in a few weeks, by breathing oxigene air.

Hypochondriasis.—Vital air might be supposed a priori, to be useful in this disorder, it has accordingly been found so in a number of cases.

Chlorosis.—Its undoubted efficacy in this affection is well attested by a number of physicians.

It has also been found of great benefit in a number of other diseases; cured some, and relieved others; as dyspepsia, melancholia, hysteria, anasarca, ascites, palsy from lead, opium, &c. the advanced stage of consumption, and diseases of pregnancy. For a full account of cases, I refer to Dr. Thomas Beddoes' considerations on the uses of facitious air. From the formidable list of diseases, many of them classed amongst the incurables of our art, in which vital air has been found serviceable, it promises to become a most valuable acquisition to the materia medica. "In desperate cases (says Chaptal) it is most certainly a precious remedy, which can spread flowers on the borders of the tomb, and prepare us in the gentlest manner for the last dreadful effort of nature."

CONCLUSION.

THUS I have endeavoured in a compendious method to trace the influence of this active agent upon the human body. My object has been chiefly to develop the fundamental principles of its operation. In doing this I have avoided as much as possible, straying into the flowery path of imagination, or launching into the open field of conjecture. I lament that I have not been able to throw more light upon this important subject by new experiments, but my time has been hitherto necessarily exhausted, in a close attention to the various other branches of the boundless science of medicine.

IN taking a review of our subject, we are naturally led to trace the progress of the powers of the mind, in acquiring a knowledge of the laws and operations of nature; but a few years ago, philosophers like the “children of the world*,” amused themselves with calculating the elasticity, the density and pressure of the air, without, perhaps, the most distant idea of its having those more important chemical properties, which we now know it to possess. If our science has already made such rapid advances, as to analyze and divide asunder, the invisi-

* Lord Bacon.

ble atmosphere which envelopes us; and to collect and administer its different parts with the utmost facility, for the cure of diseases.—If it can already command the powers of the air to its assistance, in mitigating the pangs of sickness, and alleviating the distresses of suffering humanity, what may we not expect from time and persevering industry? Go on, ye enlightened physicians and philosophers, in your noble career! boldly press forward, into the rich and fruitful field for discovery and cultivation, which is opened to your view; led by the faithful hand of experiment, and illuminated by the torch of reason; draw aside that veil of nature which hides from our eyes so many of her sublime operations! and

“ Explore with eagle eye,
 “ Where wrap’d in night retiring causes lie;
 “ Trace their flight bands, their secret haunts betray,
 “ And give new wonders to the beam of day;
 “ Till, link by link, with step aspiring trod,
 “ You climb from nature to the throne of God.”

BILLSBORROW.

And ye, Illustrious PROFESSORS OF THE UNIVERSITY OF PENNSYLVANIA, accept my warmest acknowledgments of gratitude, for those valuable instructions which I have received from your lectures: and my sincerest wishes for your individual happiness. Long, very long may ye continue with united splendor, like the bright orb of day, to diffuse the salubrious rays of medical science, in every direction, to the most distant parts of our western world; to cherish and nurture those tender plants of science, which are just putting forth their blossoms!

“ *Vive, Valeque.*”

Med. Hist.

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